NASA OAST PERSPECTIVE

Frank Stephenson
NASA Headquarters

An advanced OTV is one of a number of advanced STS vehicles that the NASA OAST Space Systems Division Transportation Systems Office has identified as candidates for future vehicle development. Vehicle requirements as well as technology needs and need dates have been established and technology programs initiated to support those potential developments in a timely manner.

It is assumed that the advanced OTV will be space based and fully reusable for low cost operations, will use aeroassist for return to low-Earth-orbit, and will evolve to a man-rated system. The propulsion system will need to maintain high performance over a wide thrust range for mission flexibility, ranging from the transfer of large, acceleration limited structures from LEO to GEO, to demanding high reliability round-trip manned missions. Technology advances are needed in propulsion, aerobraking, low-gravity cryogenic fluid management, and in environmentally compatible, low-loss cryogenic tankage. In addition, diagnostic instrumentation for monitoring the health of on-board components and systems, and automated check-out capability will enhance low-cost space based OTV operations.

The technology programs currently in place within OAST will provide the technology base in time to support a mid-1990's OTV IOC date, provided proposed FY 86 augmentations in advanced propulsion and in aerobraking technology, including a flight experiment, are approved, and if a focused technology program in light-weight, low-loss cryogenic tankage is initiated in the near future.

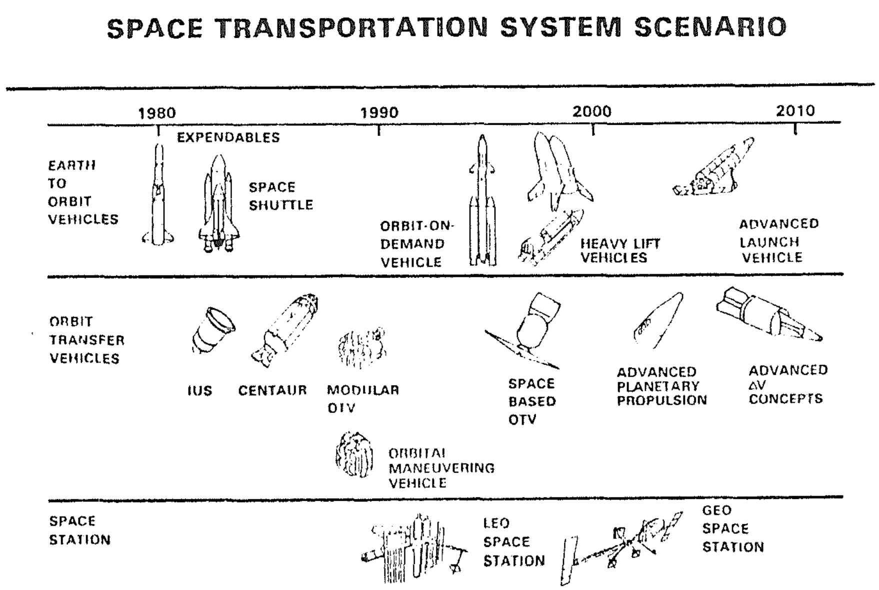


Figure 1

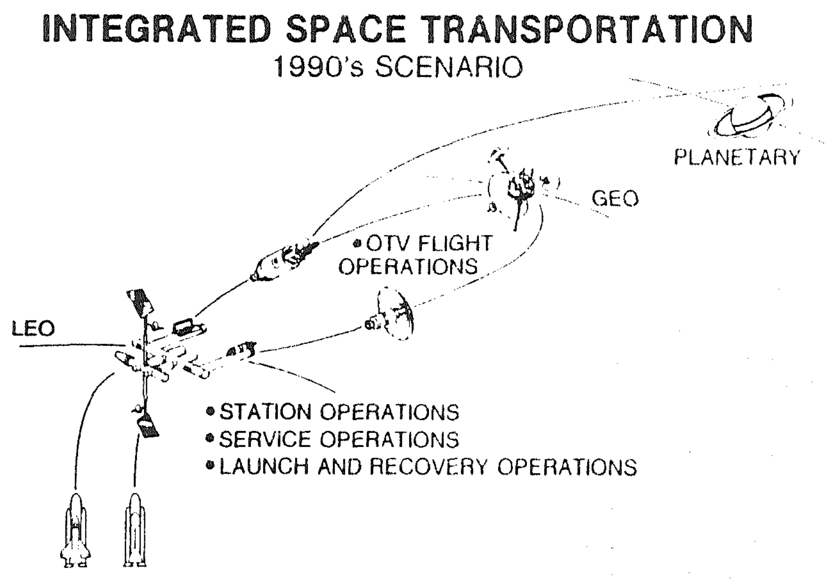


Figure 2

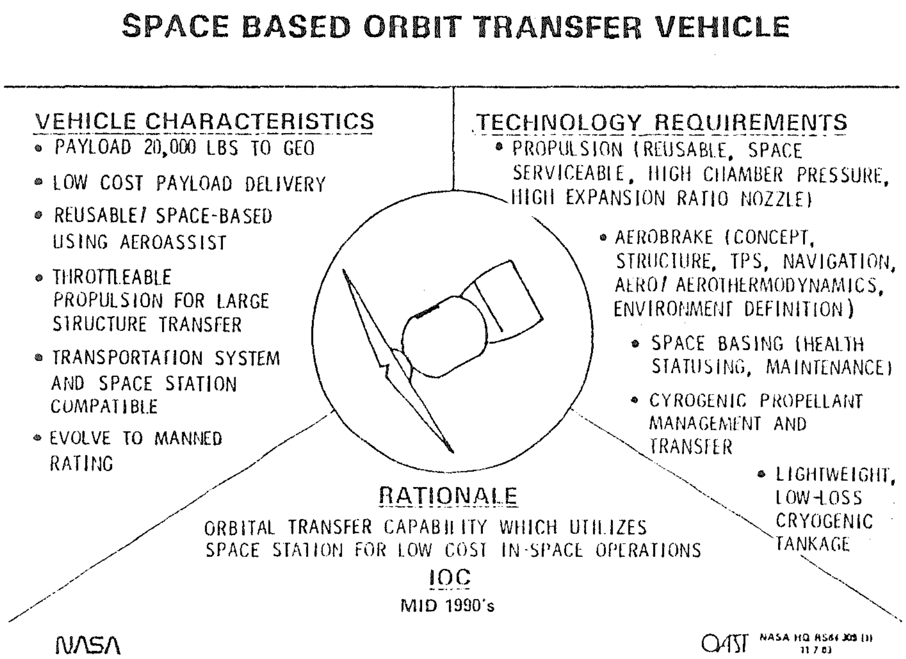


Figure 3

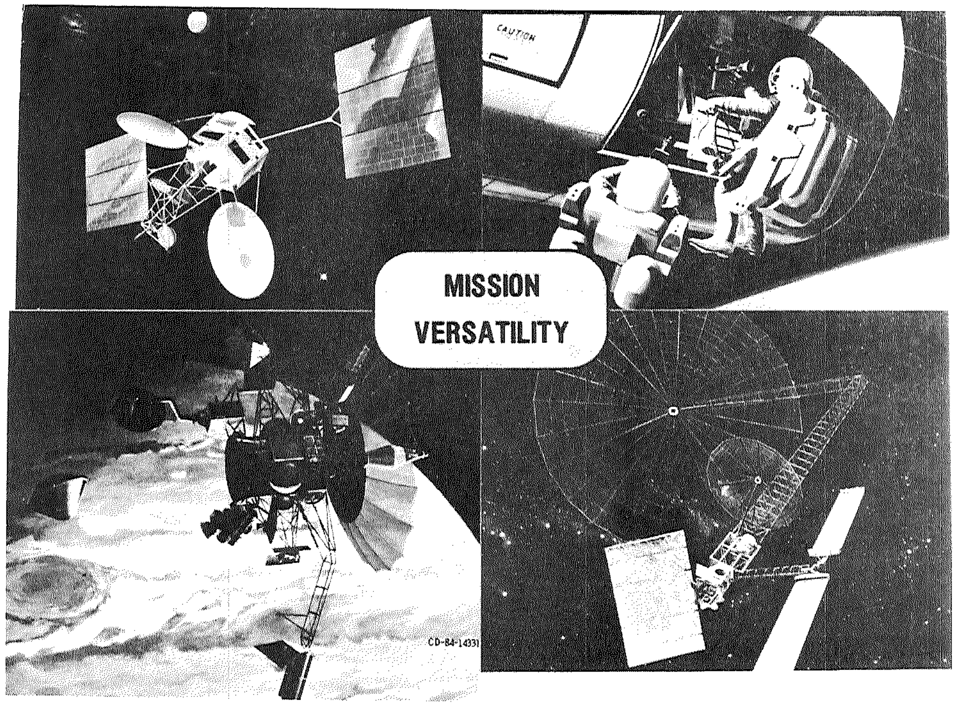


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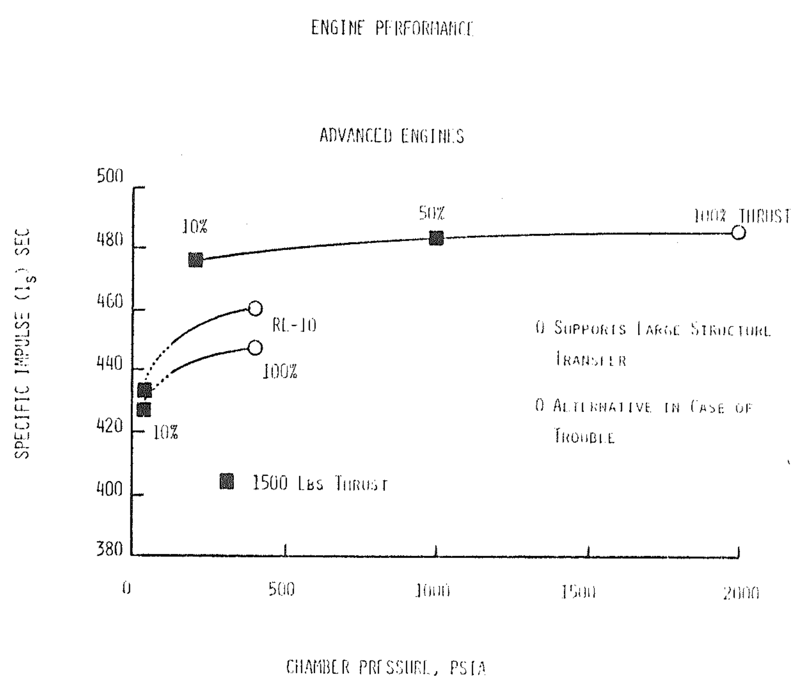


Figure 5

EFFECT ON SPECIFIC IMPULSE ON OTV PROPELLANT REQUIREMENTS

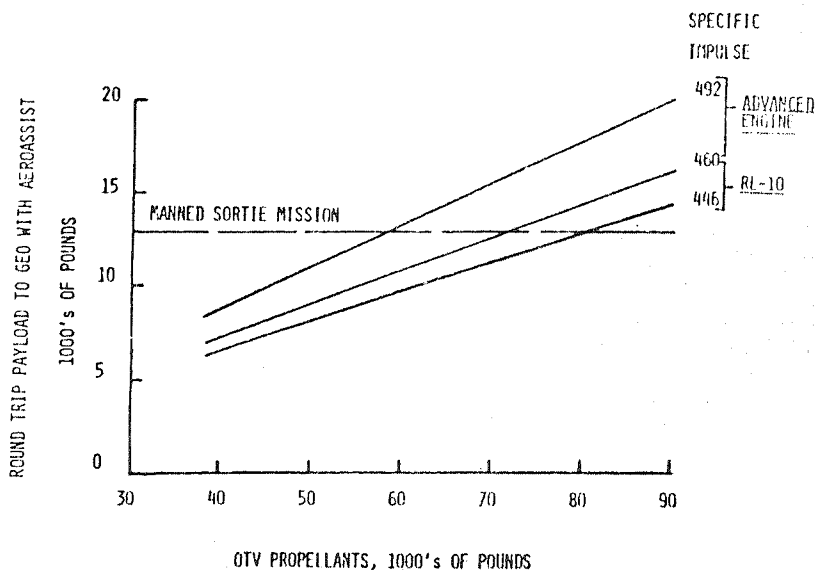


Figure 6

COST SAVINGS FROM ADVANCED ENGINES

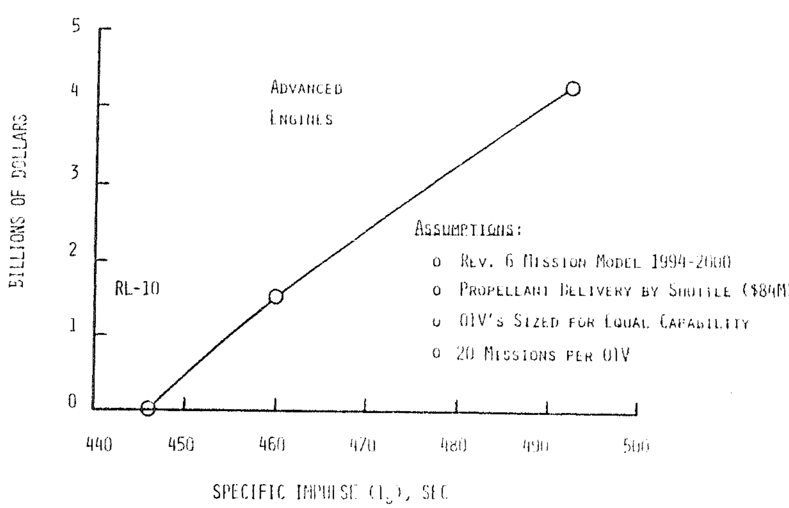


Figure 7

AERO ASSIST IMPROVES OTV

RETURN PERFORMANCE

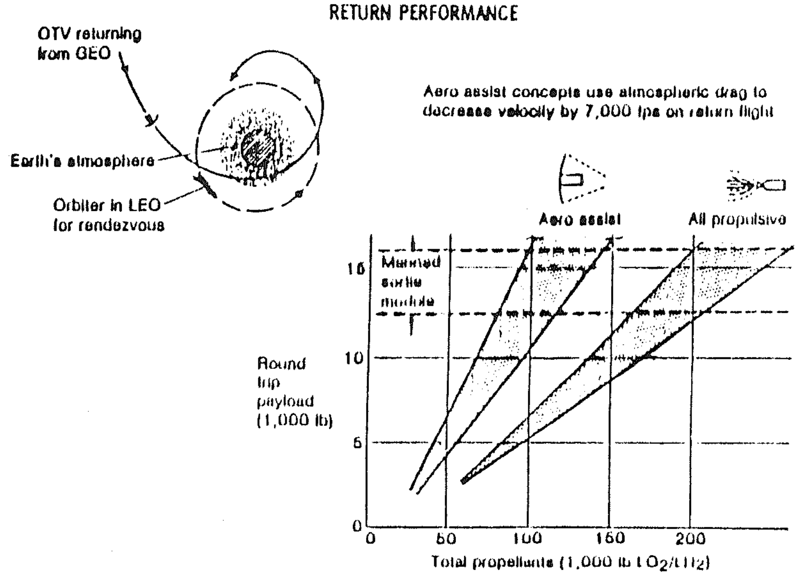


Figure 8

SHUTTLE UPPER STAGE PERFORMANCE

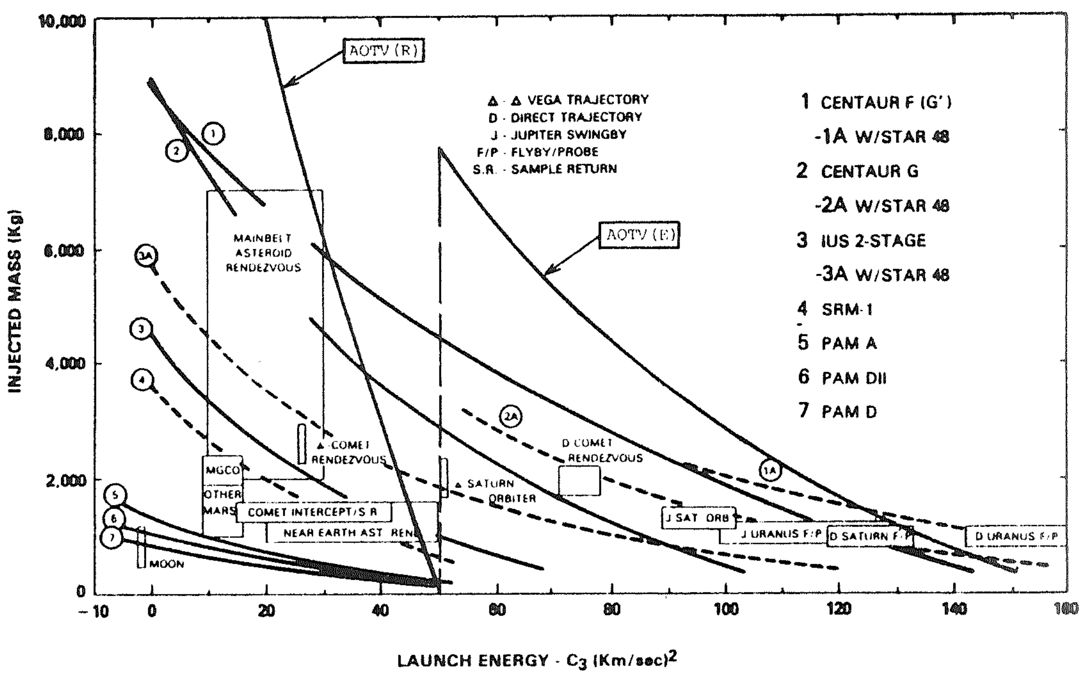


Figure 9

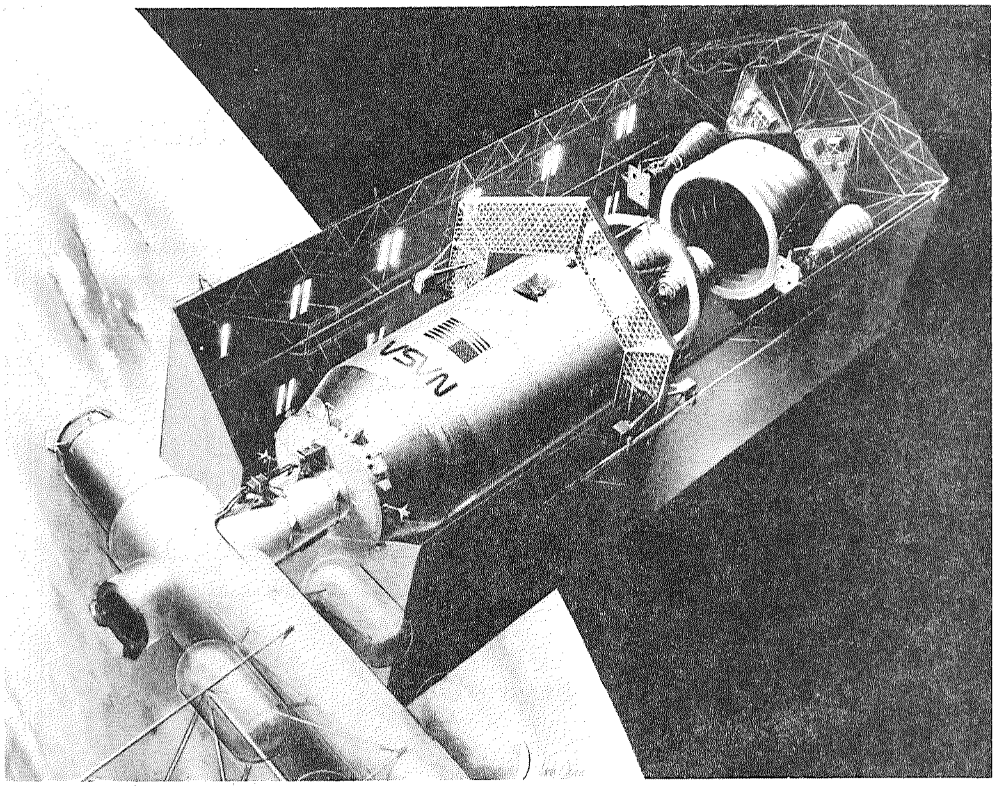


Figure 10

DIAGNOSTICS FOR MAINTAINABILITY APPROACH

ACHIEVED BY USING A BETWEEN FLIGHT AND/OR IN FLIGHT CONDITION MONITORING SYSTEM CONSISTING OF STATE OF THE ART AND/OR NOVEL AUTOMATED DETECTION TECHNOLOGIES AND TAILORED DATA PROCESSING AND COMPUTERS

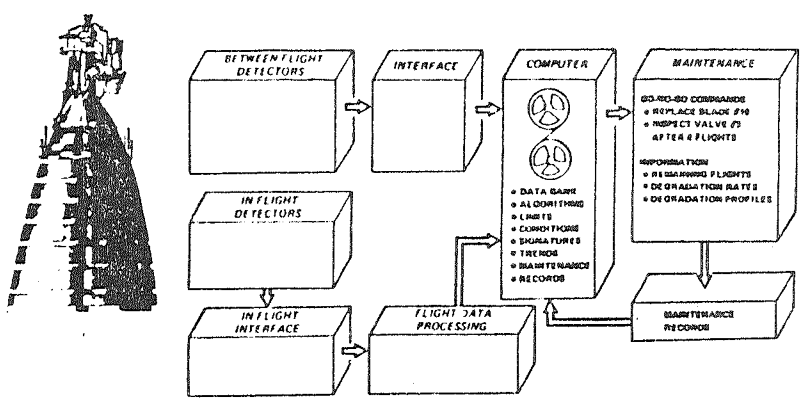


Figure 11

SPACE BASING

REQUIRES • • •

0 IN-SPACE REFUELING

MUST KNOW - PROPELLANT QUALITY

PROPELLANT QUANTITY

STATUS OF ACQUISITION DEVICES

0 SPACE COMPATIBLE TANKAGE

ENVIRONMENT/DEBRIS TOLERANT

AEROBRAKE COMPATIBLE

LOW PROPELLANT LOSS

Figure 12

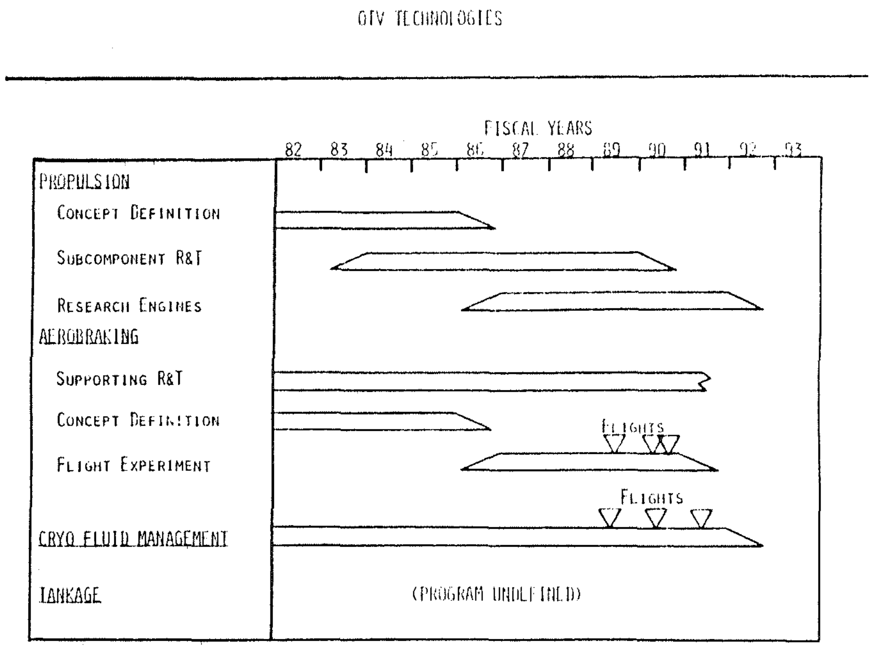


Figure 13

NASA OSF PERSPECTIVE

L. Edwards
NASA Headquarters

No text available at time of printing.

WHAT'S AN OTV

- A HIGH-PERFORMANCE UPPER STAGE FOR GENERAL USE IN THE 1990s.
  - WAS SHUTTLE-LAUNCHED
  - NOW SPACE-BASED (MAINLY? EXCLUSIVELY ?)
  - MAINLY LEO TO GEO
  - LOW COST (REUSABLE)
  - CONFIGURATION TBD

Figure 1

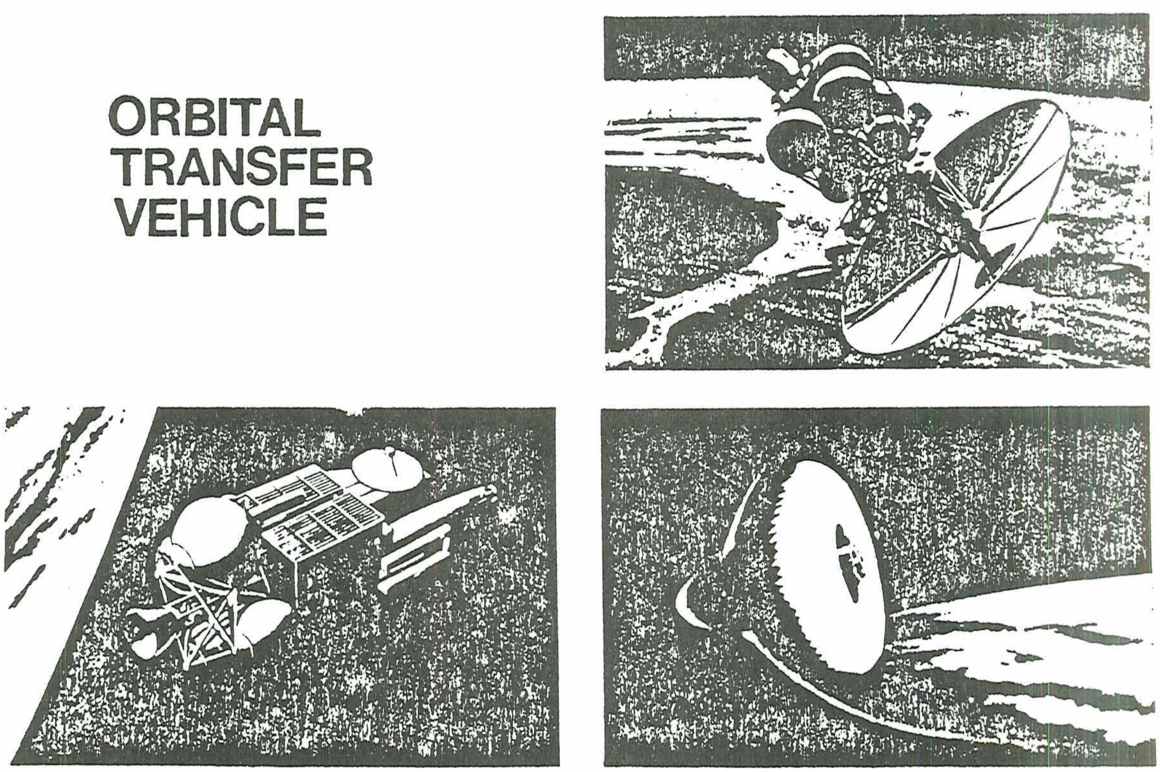
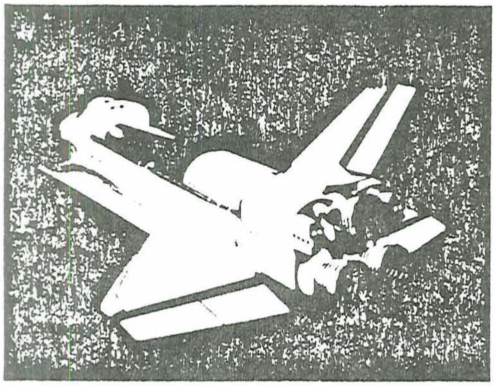


Figure 2

ORBITAL TRANSFER VEHICLE (OTV)

IN CARGO BAY



BEHIND ET

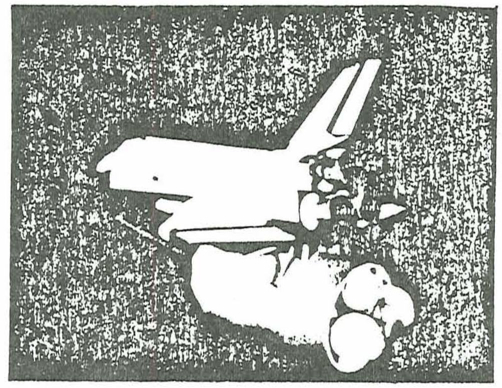
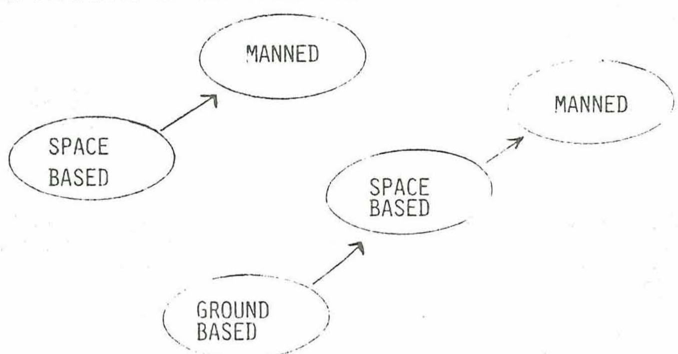


Figure 3

NASA HQ MT82-1222(3)
6-16-82

UPCOMING OTV STUDIES

- 2 CONTRACTORS, $1M EACH, 15 MONTHS
- BEST CONFIGURATION IN TWO SCENARIOS:



- IMPACT OF OTV ON SPACE STATION
  - HANGAR/MAINTENANCE
  - PROPELLANTS
  - CREW REQUIREMENTS

Figure 4

UTILIZATION OF SPACE—BASED OTV

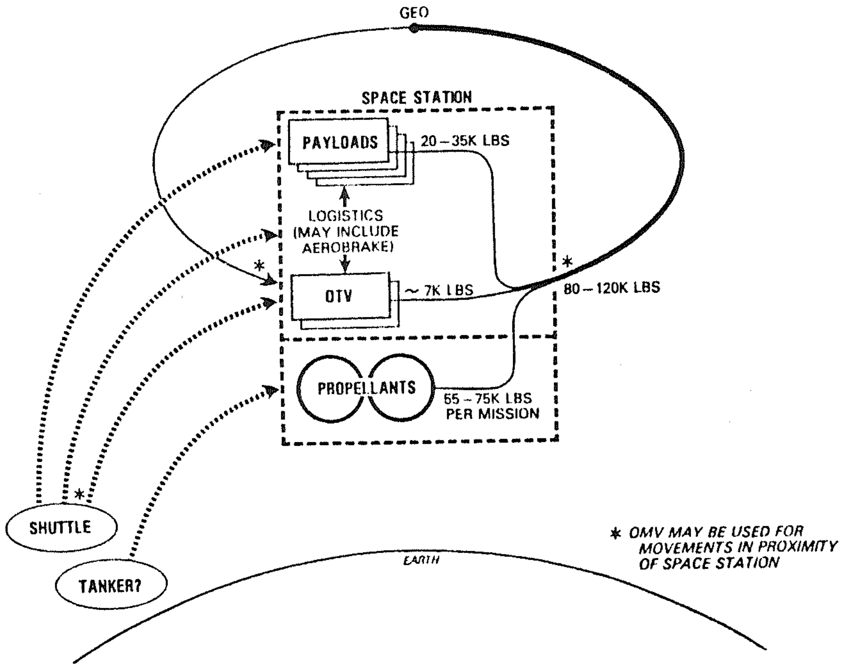


Figure 5

RELATED OTV STUDIES

AEROASSIST	OAST	MSFC ET AL	BOEING
CRYO STORAGE & HANDLING	OAST	LERC	MARTIN
SBOTV DEVELOPMENT MISSION	SSTF	MSFC	CONVAIR
SCAVENGING	OSF	JSC MSFC	ROCKWELL MARTIN
AFT CARGO CARRIER	OSF	MSFC	MARTIN
GN&C	OSF	JSC	DRAPER
MANNED OTV CAPSULE	OSF	JSC	TBD
GROUND/SPACE SUPPORT	OSF	KSC	TBD
RL10 ENGINE	OSF	LERC	PWA
ADVANCED ENGINE	OAST	LERC	3 CONTRACTS

Figure 6

CRYO vs STORABLE FOR OTV

- UPCOMING CONTRACTS WILL INCLUDE TRADEOFFS
- CRYO WILL BE NEEDED EVENTUALLY
- CRYO TAKES ADVANTAGE OF SCAVENGING FROM ET
- ONLY CRYO PERMITS SINGLE REUSABLE STAGE FOR SPACE-BASED MISSIONS
- INTERESTING POSSIBILITY FOR MANNED GEO MISSIONS:
  - CRYO/EXPENDABLE GOING TO GEO
  - STORABLE/REUSABLE FOR LOITER AND RETURN

Figure 7

KEY REQUIREMENTS FOR OTV ENGINE

- SUITABLE FOR SPACE BASING & REUSE
  - LONG LIFE, MANY STARTS
  - EASY CHECKOUT
  - EASY SERVICING/MAINTENANCE/REPLACEMENT UNLESS THESE CAN BE SHOWN TO BE UNNECESSARY
- COMPATIBLE WITH AEROBRAKE
- I_S AT LEAST 460 SECONDS
- THRUST 15-20K POUNDS (MR 6:1)
- ALTERNATE THRUST ~1500 POUNDS (NO KITS)
  - VARIABLE THRUST MAY BE USEFUL BUT NOT MANDATORY
- STOWED LENGTH NOT OVER 55 INCHES
- OCCASIONAL MANNED FLIGHTS
  - MAY REQUIRE DUAL ENGINES

Figure 8

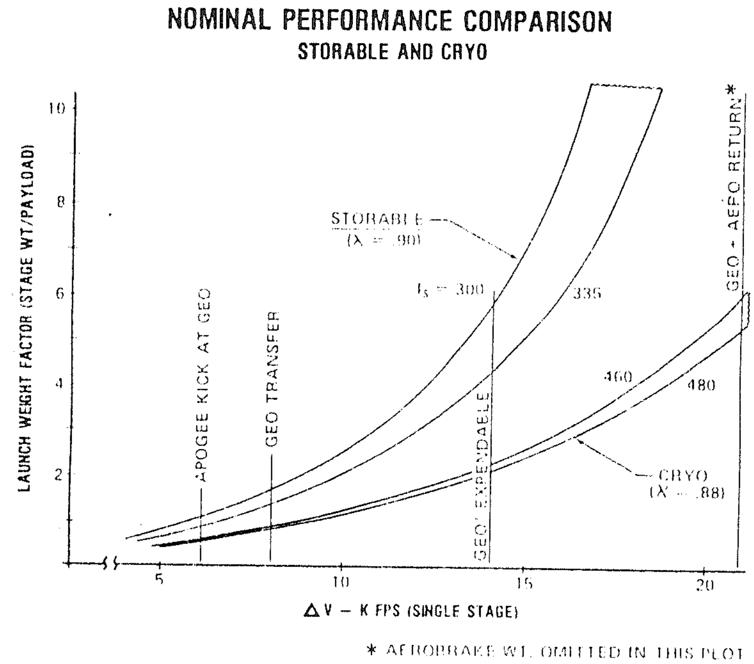


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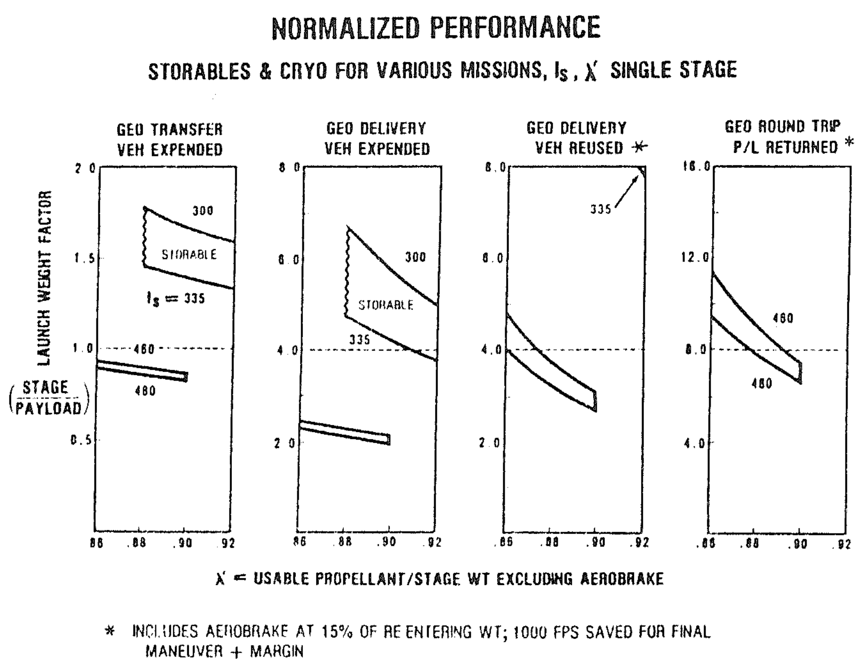


Figure 10

SPACE STATION SCENARIOS
ARBITRARY 20K PAYLOAD TO GEO

PRELIMINARY
L.E. 3-2-84

	SCENARIO	1st STAGE PROP.	1st STAGE BOW	2nd STAGE PROP.	2nd STAGE BOW	MUST REPLACE
		λ' = .90		λ' = .85		
STORABLES I_s = 312/342	S1: ONE STAGE EXPENDABLE	92/72	10/8	-	-	PROP. + 1 VEHICLE 120-80 K LBS
	S2: ONE STAGE REUSABLE*	-/219	-/24	-	-	PROPELLANTS ∞ - 219 K
	S3: TWO STAGES EXPENDABLE	60/48	6.7/5.3	19/17	3/4/3.0	PROP. + 2 VEHICLES 89-73 K
	S4: TWO STAGES; ONE STAGE REUSABLE*	65/51	7/6	19/17	3.4/3.0	PROP. + 1 VEHICLE 87-71 K
		λ' = .88				
CRYO I_s = 460	C1: ONE STAGE EXPENDABLE	40	5.5	-	-	PROP. + 1 VEHICLE 46K + BOILOFF
	C2: ONE STAGE, REUSABLE*	65	10.5	-	-	PROPELLANTS 65K + BOILOFF

* INCLUDES AEROBRAKE @ 15% OF REENTRY WEIGHT.

Figure 11

RESUPPLY REQUIREMENT FOR SPACE STATION SCENARIOS
ARBITRARY 20K PAYLOAD TO GEO

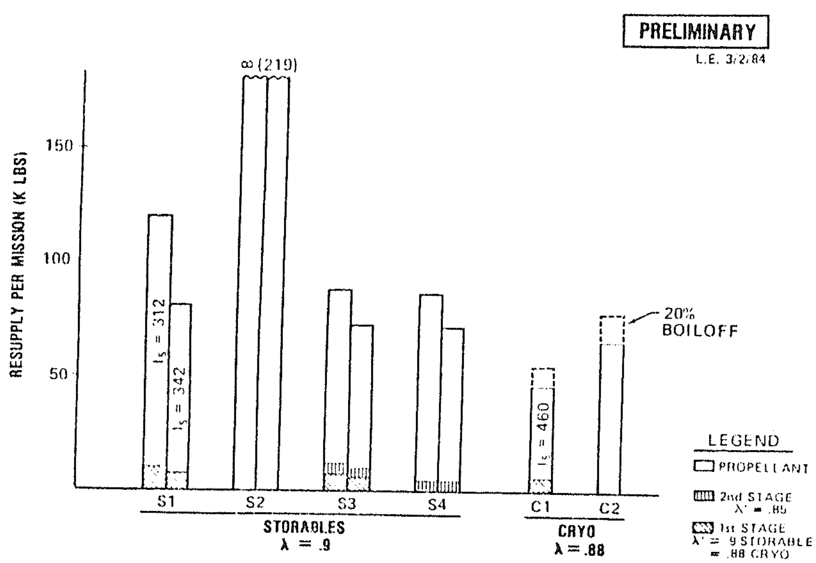


Figure 12